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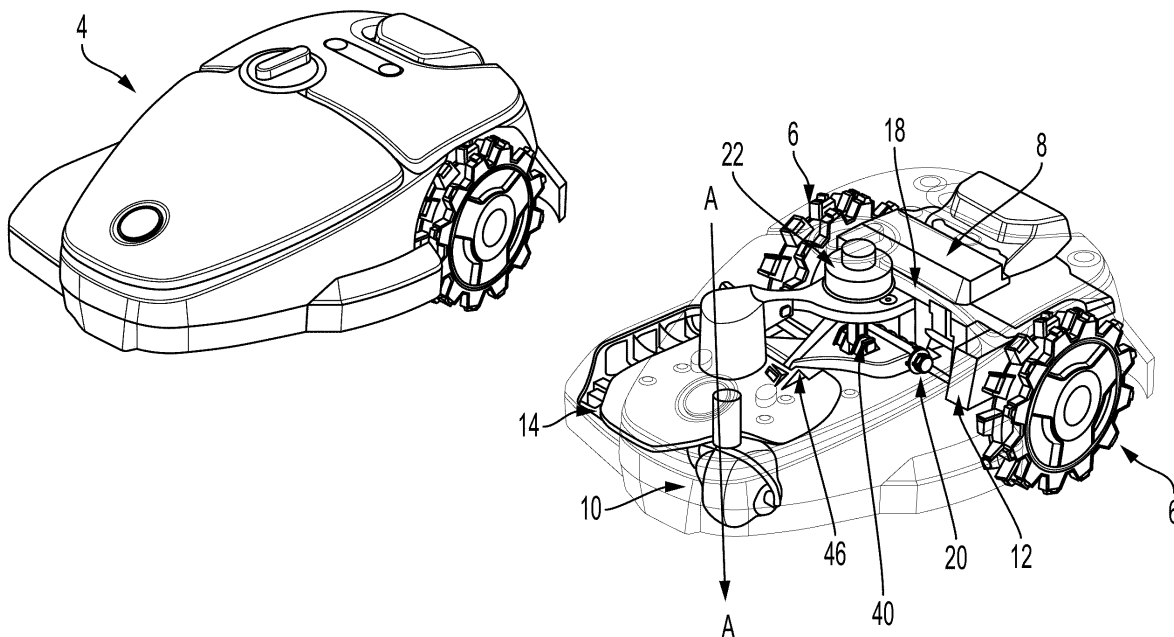
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(57) A height adjustment mechanism (22, 24, 40) for a mower (4) is disclosed in which the adjustment mechanism includes a pair of arms (36, 38), set opposite

each other so that any stresses generated during alteration of the mower deck (14) height are dispersed in order to reduce the chance of damage to the mechanism.

**FIG. 2**

Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to height adjustment mechanisms for mower and has particular, although not exclusive, relevance to such mechanisms as are employed in robotic mowers. During use of a mower, it is usual for a user of the mower whether it is autonomous (such as a robotic mower), or manually operated (such a push- or ride-on mower), to want to adjust the height of the cut. This is so that the length of the vegetation (such as grass) after the cut has been performed is both predetermined and uniform.

[0002] Height adjustment mechanisms for mowers are known. For example, EP4062738 discloses one such mechanism.

[0003] A problem associated with such height adjustment mechanisms is their vulnerability to damage, given the rough environment in which the mower is operated. A further problem is the frequency of which the blade cutting height of the mower is altered can mean the height adjustment mechanism may be subject to accelerated wear, which can render the mechanism faulty or even broken.

[0004] There exists, therefore a desire to employ a height adjustment mechanism which is robust and less likely to suffer damage or failure than the prior art mechanisms.

SUMMARY OF THE INVENTION

[0005] According to the present invention, therefore, there is provided a height adjustment mechanism for a mower, the mower comprising a wheel-mounted chassis, at least one motor mounted on the chassis, and a cutting mechanism held within a moveable deck, the moveable deck hingedly coupled to the chassis;

the at least one motor able to provide drive for the wheels and/or the cutting mechanism, as the mower travels, on its wheels, along a surface;

wherein manual actuation of the height adjustment mechanism allows a user of the mower to alter the height of the moveable deck relative to the surface, the height adjustment mechanism comprising:

- i) a manually rotatable knob;
- ii) a cam mechanism, rotatable about a plane of rotation, on rotation of the knob;
- iii) a cam follower, moveable along an axis, which axis is orthogonal to the plane of rotation of the cam mechanism;

wherein rotation of the cam mechanism acts on the cam follower to cause the cam follower to move along the axis and wherein movement of the cam

follower adjusts the position of the deck relative to the wheels;

characterised in that the cam mechanism comprises two semi-circular stepped surfaces and in that the cam follower comprises two complimentary engagement surfaces, each respective stepped surface of the cam mechanism mating with a corresponding respective engagement surface of the cam follower.

[0006] Such a height adjustment mechanism has the advantage that use of a cam mechanism comprising two semi-circular surfaces shares the load which the mechanism carries when the height of the cutting deck is being adjusted. This means less stress on the component parts of the cam follower, as it, too is split into two parts each having its own complimentary engagement surface. As the component parts of the mechanism suffer less stress, the mechanism is more robust than the prior art.

[0007] Preferably the cam follower is hingedly coupled to a first lift arm, which first lift arm is also hingedly coupled to the cutting deck. And the first lift arm may further be hingedly coupled to the chassis. Also the first lift arm may be further hingedly coupled to the chassis. This structure permits of easy movement of the cutting deck when the cut height is to be altered.

[0008] Advantageously the cam mechanism, the first lift arm, the second lift arm and the cutting deck together form a 4-bar linkage able to move the cutting deck relative to the chassis such that the movement is a translation, ensuring the attitude of the cutting deck to the surface does not change with the height of the deck relative to the surface. Use of such an arrangement ensures the movement of the cutting deck is parallel to the surface to be cut and avoids any pivoting of the deck as it moves. This, in turn, ensures the plane of rotation of the cutting blades housed within the cutting deck, does not pivot relative to the surface to be cut.

[0009] In a preferred embodiment the cam mechanism is formed integrally with the rotatable knob. This permits of ease of manufacture and assists in controlling production costs.

[0010] Each of the two semi-circular stepped surfaces of the cam mechanism may comprise a plurality of individual steps of differing axial extent. And each of the individual steps may possess an area formed thereon which forms a stable platform against which the respective cam follower complimentary engagement surfaces may rest. In this manner, known height indexing adjustments may be made by a user of the mower.

[0011] Preferably a return spring is coupled between the cutting deck and the first lift arm, which spring urges the deck into its highest position away from the surface to be cut.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] In a preferred embodiment the mower is a robotic mower.

[0013] An embodiment of the present invention will now be described, by way of example only and with reference to the accompanying drawings, of which:

Figure 1 shows a schematic perspective view of a mower in accordance with the present invention;

Figure 2 shows a schematic view, from the other side to that of Fig 1, but with the mower body removed;

Figure 3 shows another schematic perspective view, but with the body shown in ghost outline and also removed;

Figure 4 shows a schematic perspective view, from below, of the mower without the body in place;

Figure 5 shows perspective and side views of the cam, cam follower and lift arms;

Figure 6 shows side views of the height adjustment mechanism in two different height positions;

Figure 7 shows a perspective view of the internal structure of the cam mechanism;

Figure 8 shows views of the progression of movement as between the cam and cam follower as the deck height is adjusted;

Figure 9 shows a series of side views of the deck height being adjusted, and;

Figure 10 illustrates an example of various height settings shown on the adjustment knob.

DETAILED DESCRIPTION OF THE INVENTION

[0014] Referring initially to Fig 1, it can be seen that a mower 2, in this case robotic mower (a term generally understood by those skilled in the art to encompass autonomous mowers which are able to cut an area of vegetation without direct user control) having a body 4 and being driven by a pair of rear-mounted wheels 6. The wheels 6 are driven by a motor, in this example an electric motor 8 powered by a rechargeable battery (not shown, but well-known to those skilled in the art). The mower 2 has single front wheel 10, which functions as a castor, being freely rotatable about an axis A-A. The direction of the mower when the wheels 6 are being driven by the motor 8 is controlled by differential speed as between each of the two driving wheels 6, in conventional manner. The front wheel 10 is not a driving wheel and is not powered, in this example, although could be, if required.

[0015] The mower 2 includes a wheel-mounted chassis 12. The chassis provides a framework upon which the functioning components of the mower sit on the wheels 6, 10 and support the body 4. Reference also to Figs 2-4 illustrate this. The motor 8 sits on the chassis 12, as can be seen most clearly from Fig 2.

[0016] The chassis 12 also provides a support structure for a cutting deck 14. The cutting deck 14 (as can be seen best from Fig 4) includes a rotatable disc having a set of blades formed thereon 16. The disc and blades 16 can be driven by motor 8, or by a separate motor (not shown in this example). This would enable the cutting disc (the means by which the vegetation growing on the surface along which the mower moves may be cut) to be powered independently of the mower movement. However, in the illustrated example, the single motor 8 powers both the wheels 6 and cutting disc 16. In this example, the drive is directly supplied to both the wheels 6 and disc 16, but could, for example, be via gearboxes in order to regulate speed, or torque as appropriate for the terrain on which the mower moves and the vegetation to be cut.

[0017] The cutting deck 14 is coupled to the chassis 12 at two places: an upper connection 18 and a lower connection 20 (see Figs 2, 3 and 5). The distance (or separation) between the cutting deck 14 and the wheels 6, 10 may be manually adjusted by a user of the mower in order to govern the amount of vegetation cut by the disc 16. A height adjustment mechanism (to be described, below) achieves this. The alteration of the height of the deck above the wheels 6, 10 (and, hence above the surface upon which the mower sits and moves) is controlled in such a way as to ensure only an up-down translation of the deck 14. The deck maintains its alignment with the plane, P-P (as illustrated in Figs 6 and 9) of the cutting disc and does not pivot relative thereto. This ensures a uniform cut of the vegetation as the disc and blades 16 rotate.

[0018] Referring now also to Figs 5-9, the height adjustment mechanism will be explained. A manually rotatable knob 22 projects outside the body 4 so that it may be readily held by the hand of a user of the mower 2. Depending upon the sense of rotation of the knob 22, the user may cause the height of the deck 14 relative to the wheels 6, 10 (or, indeed the height of the deck above the surface upon which the mower rests or travels) to increase or decrease.

[0019] Either formed integrally with the knob 22, or coupled thereto (in either instance, such that it may rotate with rotation of the knob 22) is a cam mechanism 24. The cam mechanism 24 rotates within a plane of rotation R-R (Fig 6) upon rotation of knob 22, but is axially immovable, being held to the mower body 4.

[0020] Formed on the inside of the cam mechanism facing away from the knob 24 is a series of arcuately formed steps 26 (Fig 8). The steps also extend along an axis B-B, which is orthogonal to the plane R-R. In this manner, the steps 26 form part of a spiral "staircase" such that a series of lands 28 (having no axial extent) are

interspersed with a series of ramps (having both axial and circumferential extent) 30. The purpose of the lands 28 and ramps 30 will become apparent from the description, below.

[0021] It can be seen that the steps 26 are formed in two arcuate semi-circles, each of which meets its neighbour at a boundary wall 32. This dual semi-circular construction of the cam mechanism is an important component of the invention. The two arcuate semi-circles are, in this example, diametrically-opposed.

[0022] Cooperating with the cam mechanism 24 is cam follower 34. Cam follower 34 (see Fig 8) is formed with two opposing follower members 36, 38, each of which cooperates with a respective one of the arcuate steps 26 either side of the boundary wall 32. As with the two arcuate semi-circles, the two opposing follower members 36, 38 are, in this example, formed diametrically opposite to one another.

[0023] Because the steps 26 are formed in two diametrically-opposed arcuate semi-circles, as the cam mechanism 24 rotates on rotation of the knob 22, then the cam follower arms 36, 38 will ride axially (along axis B-B) up or down the steps in unison. Each cam follower arm 36 and 38 will ride up or down its respective semi-circular range of steps, of course. The cam follower 34 has an axially extending body component 40 which is rotationally restrained, but able to move along the axis B-B concomitantly with rotation of the cam mechanism 24, as a result of the cooperation between the steps 26 and arms 36, 38. In this manner, therefore, as knob 22 is rotated, so is cam mechanism 24 rotated and so the cooperation between the steps 26 and arms 36, 38 causes the cam mechanism body 40 to move up or down along axis B-B. The cam mechanism body 40 translates up or down along axis B-B.

[0024] Use of two opposing arms 36, 38 (ie at 180° to each other) distributes torque stresses placed upon both the cam mechanism 24 and the cam follower 34 evenly and oppositely, meaning that a smooth movement of the body 40 up or down the axis B-B may be achieved.

[0025] The cam follower 34 is hingedly (or otherwise pivotally) coupled to a first lift arm 42 via hinge joint 44 (see Fig 5) at a position between the first lift arm's proximal and distal ends. This enables a pivoting relationship as between the cam follower body 40 and the first lift arm 42. The proximal end of the first lift arm 42 is hingedly coupled to the chassis 12 at pivot joint 45. The distal end of the first lift arm 42 is hingedly coupled to the cutting deck 14 and pivot joint 46 (see Fig 9). This corresponds to the lower connection 20, discussed above.

[0026] A second lift arm 48 is hingedly coupled at its proximal end to the chassis 12 via hinge joint 50 and coupled to the cutting deck 14 at its distal end via hinge joint 52 (see Fig 9). This corresponds to the upper connection 18, discussed above.

[0027] The combined arrangement of the cam follower 34 body 40, the first lift arm 42, the second lift arm 48, the chassis 12 and cutting deck 14 and the manner in which

they are all interconnected, as explained above, provides a so-called "4-bar linkage" mechanism (which is understood by those skilled in the art). Such a 4-bar linkage permits the height adjustment of the cutting deck 14 to be achieved as a translation (ie the up- and down- movements of the cutting deck 14) are always parallel to the plane P-P. In this manner, there is no possibility of the angle of the cutting deck 14 relative to the wheels 6, 10, or surface 54 on which the wheels roll, altering as the cutting deck 14 is moved up or down. This ensures a consistent attitude of the cutting deck 14 to both the wheels 6, 1 and surface 54.

[0028] The use of the lands 28 in the steps 26 of the cam mechanism 24 provides a series of stable platforms (along the arcuately-extending steps 26) upon which the respective arms 36, 38 may be stably held unless and until the user further rotates knob 22. This means a series of known index positions of the cutting deck 14 may be achieved.

[0029] The knob 22 may carry height markings such that the user may rotate the knob in the correct sense and by a known amount in order to achieve the displayed cut height for the cutting deck. An example of such height markings is shown as 56 (Fig 10).

[0030] It is advantageous for the cutting deck to be biased toward its highest position relative to the wheels 6, 10 and surface 54. This is due the effect of gravity tending to urge the cutting deck 14 downwards. In this embodiment a return spring 56 (see Fig 9) is employed to provide an upwardly biasing force to the cutting deck 14.

Claims

1. A height adjustment mechanism for a mower, the mower comprising a wheel-mounted chassis, at least one motor mounted on the chassis, and a cutting mechanism held within a moveable deck, the moveable deck hingedly coupled to the chassis;

the at least one motor able to provide drive for the wheels and/or the cutting mechanism, as the mower travels, on its wheels, along a surface; wherein manual actuation of the height adjustment mechanism allows a user of the mower to alter the height of the moveable deck relative to the surface, the height adjustment mechanism comprising:

- i) a manually rotatable knob;
- ii) a cam mechanism, rotatable about a plane of rotation, on rotation of the knob;
- iii) a cam follower, moveable along an axis, which axis is orthogonal to the plane of rotation of the cam mechanism;

wherein rotation of the cam mechanism acts on the cam follower to cause the cam follower to

move along the axis and wherein movement of the cam follower adjusts the position of the deck relative to the wheels;

characterised in that the cam mechanism comprises two semi-circular stepped surfaces and **in that** the cam follower comprises two complimentary engagement surfaces, each respective stepped surface of the cam mechanism mating with a corresponding respective engagement surface of the cam follower.

2. A height adjustment mechanism according to claim 1 wherein the cam follower is hingedly coupled to a first lift arm, which first lift arm is also hingedly coupled to the cutting deck.
3. A height adjustment mechanism according to either claim 1 or claim 2 wherein the first lift arm is further hingedly coupled to the chassis.
4. A height adjustment mechanism according to any one of the preceding claims wherein a second lift arm is hingedly coupled to the cutting deck.
5. A height adjustment mechanism according to claim 5 wherein the cam mechanism, the cam follower, the first lift arm, the second lift arm and the cutting deck together form a 4-bar linkage able to move the cutting deck relative to the chassis such that the movement is a translation, ensuring the attitude of the cutting deck to the surface does not change with the height of the deck relative to the surface.
6. A height adjustment mechanism according to any one of the preceding claims wherein the cam mechanism is formed integrally with the rotatable knob.
7. A height adjustment mechanism according to any one of the preceding claims wherein each of the two semi-circular stepped surfaces of the cam mechanism comprises a plurality of individual steps of differing axial extent.
8. A height adjustment mechanism according to claim 7 wherein each of the individual steps has an area formed thereon which forms a stable platform against which the respective cam follower complimentary engagement surfaces may rest.
9. A height adjustment mechanism according to any one of the preceding claims wherein a return spring is coupled between the cutting deck and the first lift arm, which spring urges the deck into its highest position away from the surface to be cut.
10. A height adjustment mechanism according to any one of the preceding claims wherein the mower is a robotic mower.

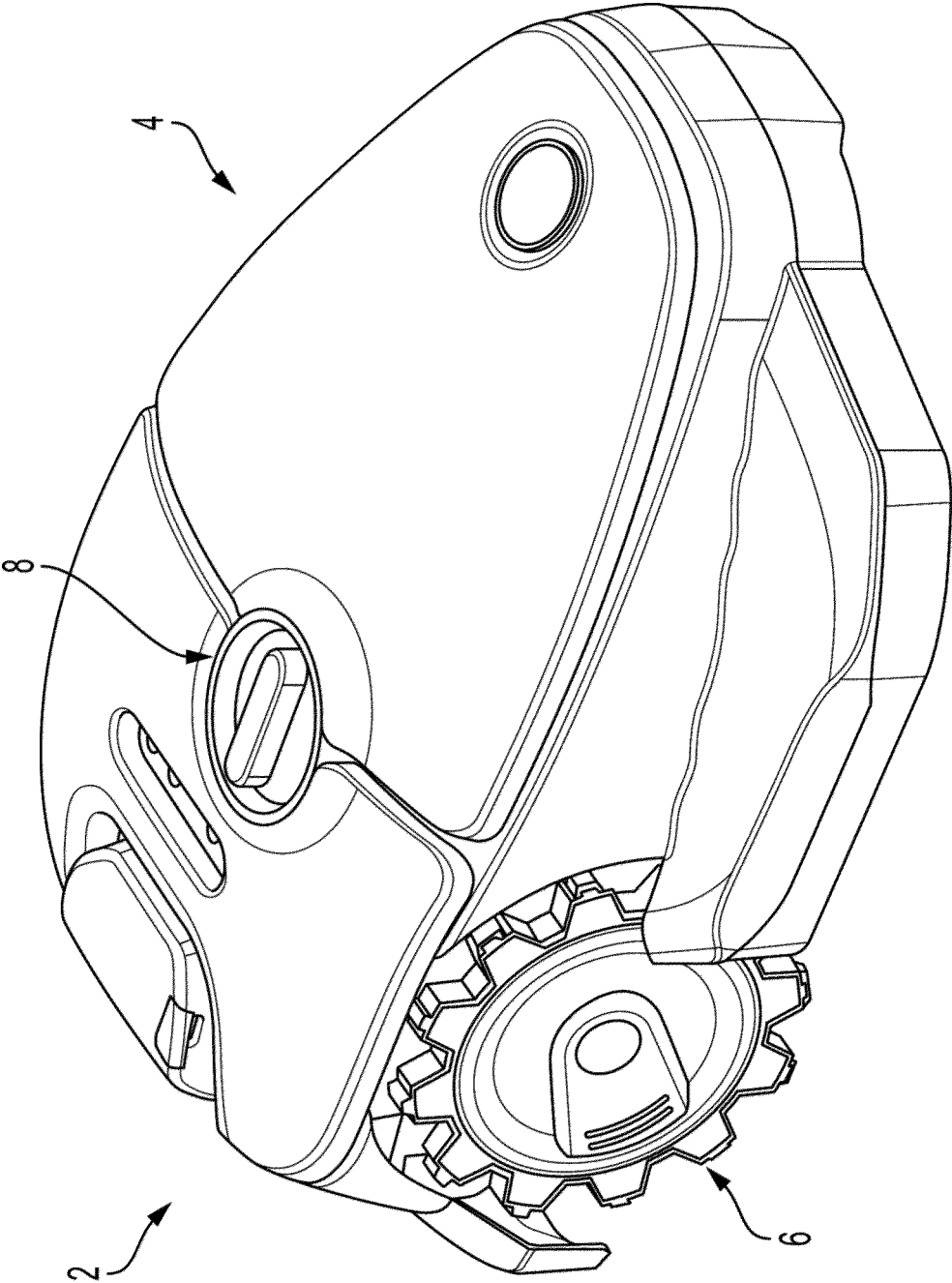


FIG. 1

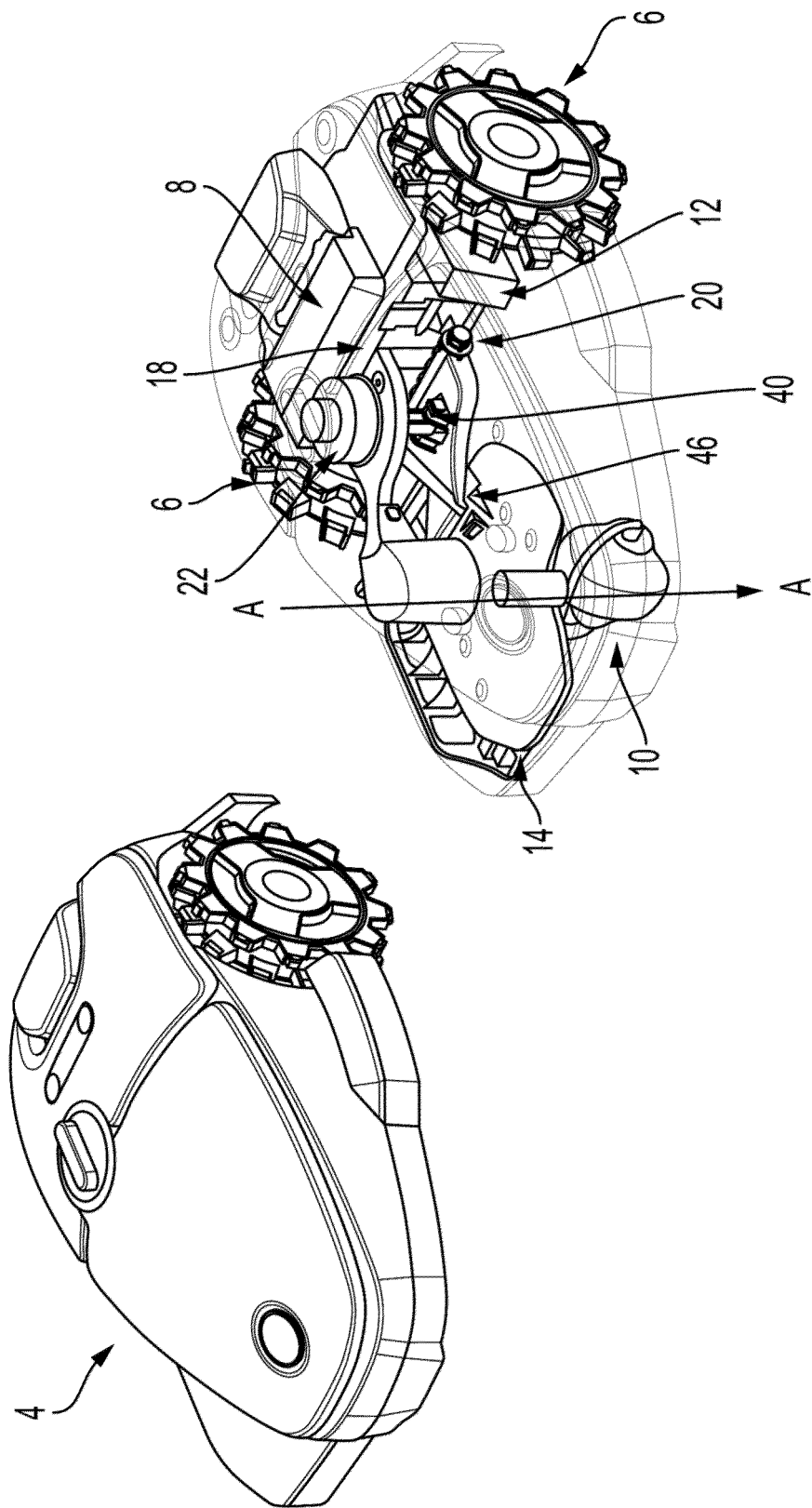
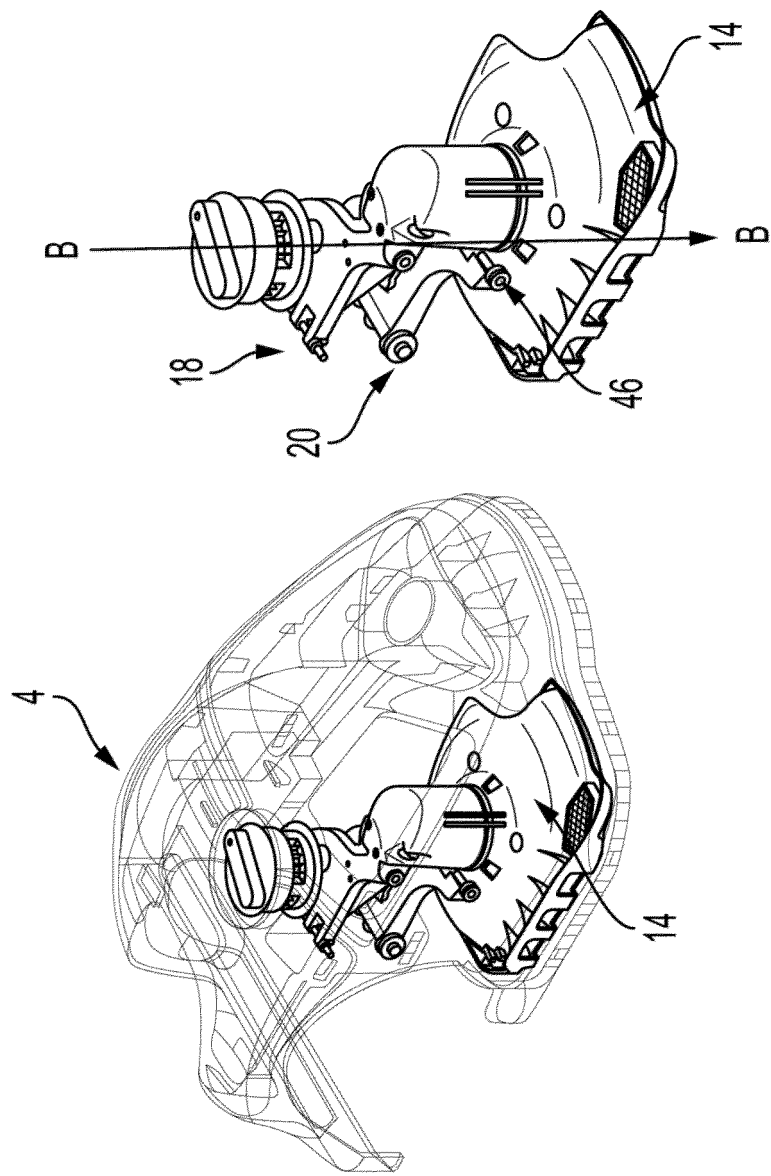


FIG. 2



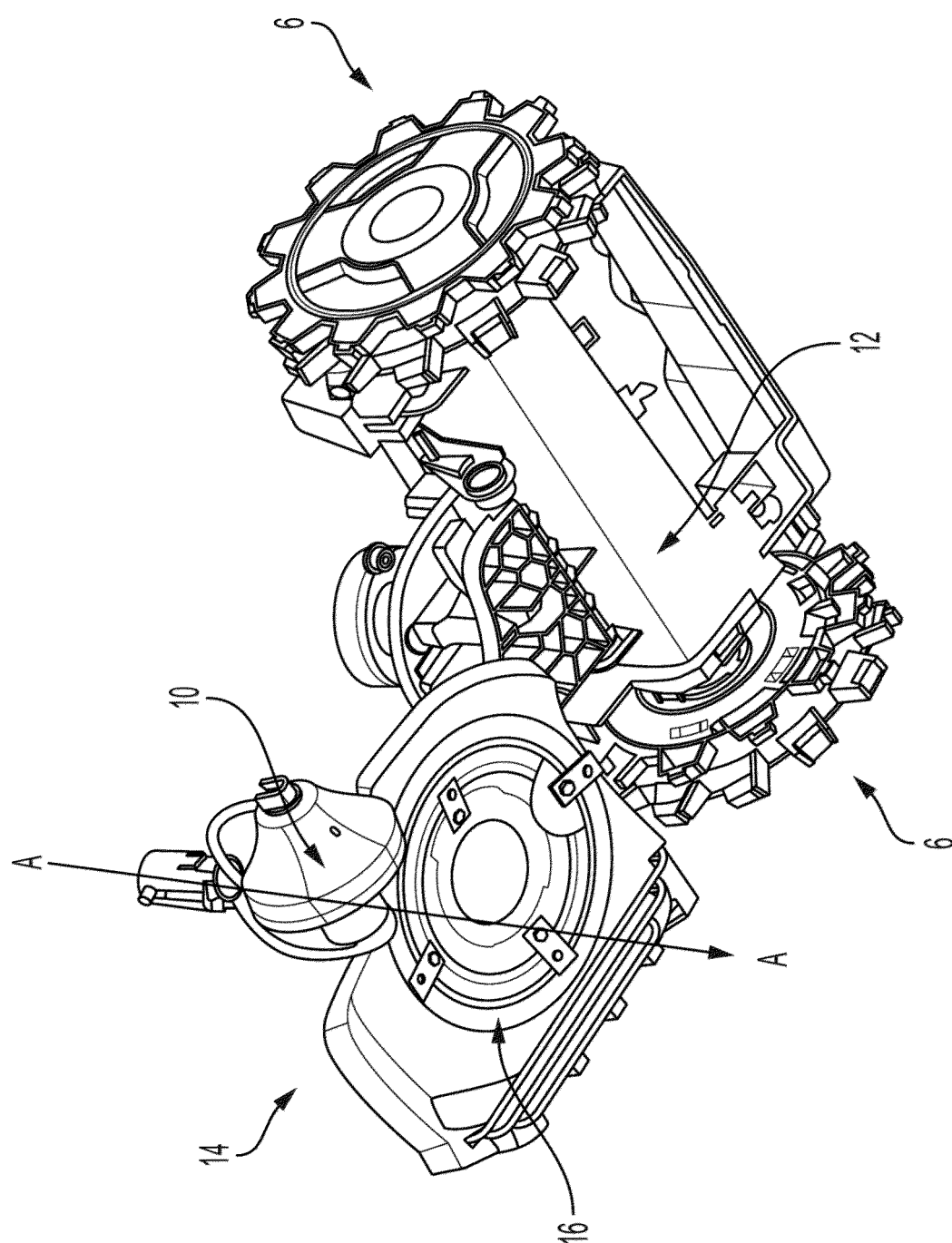


FIG. 4

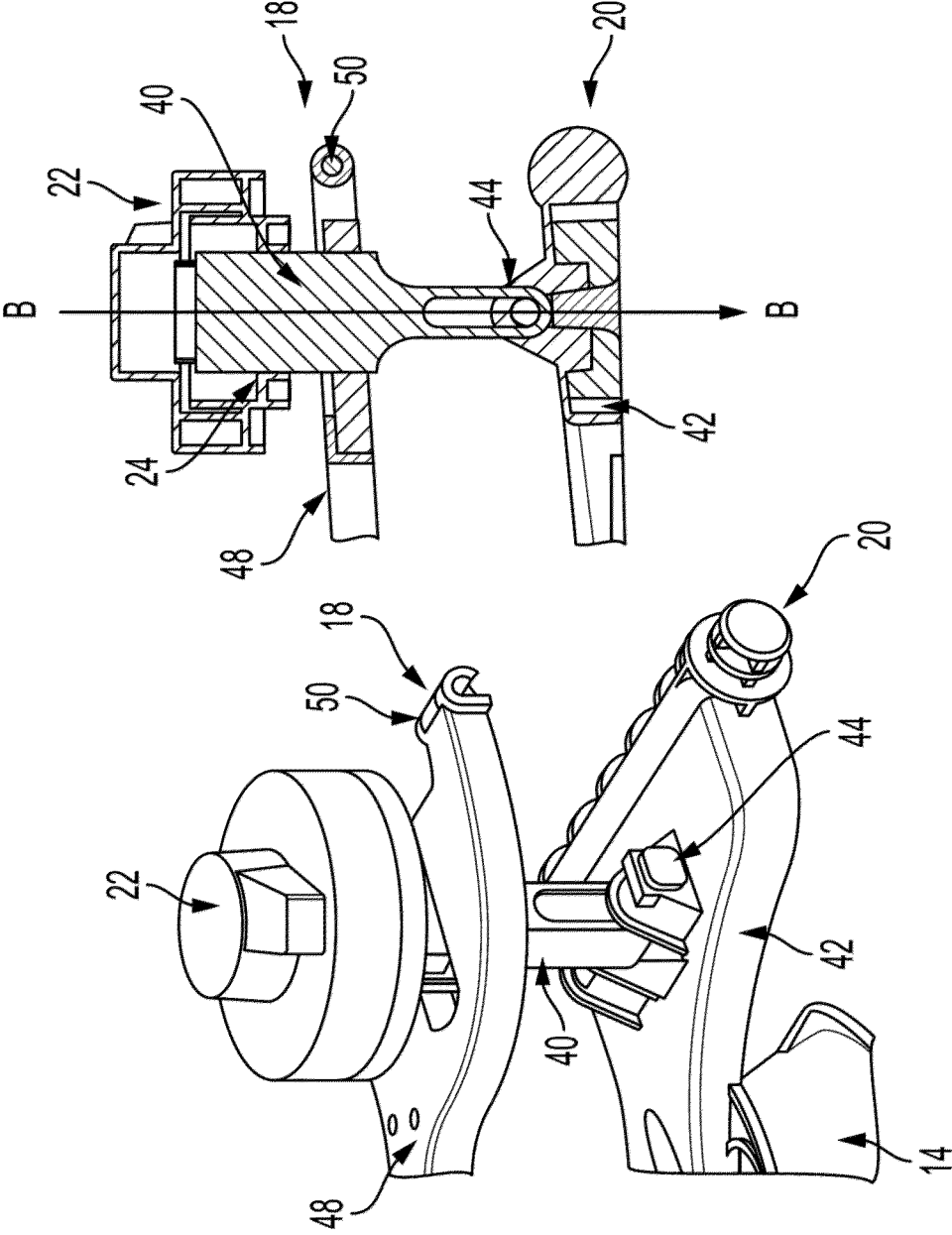


FIG. 5

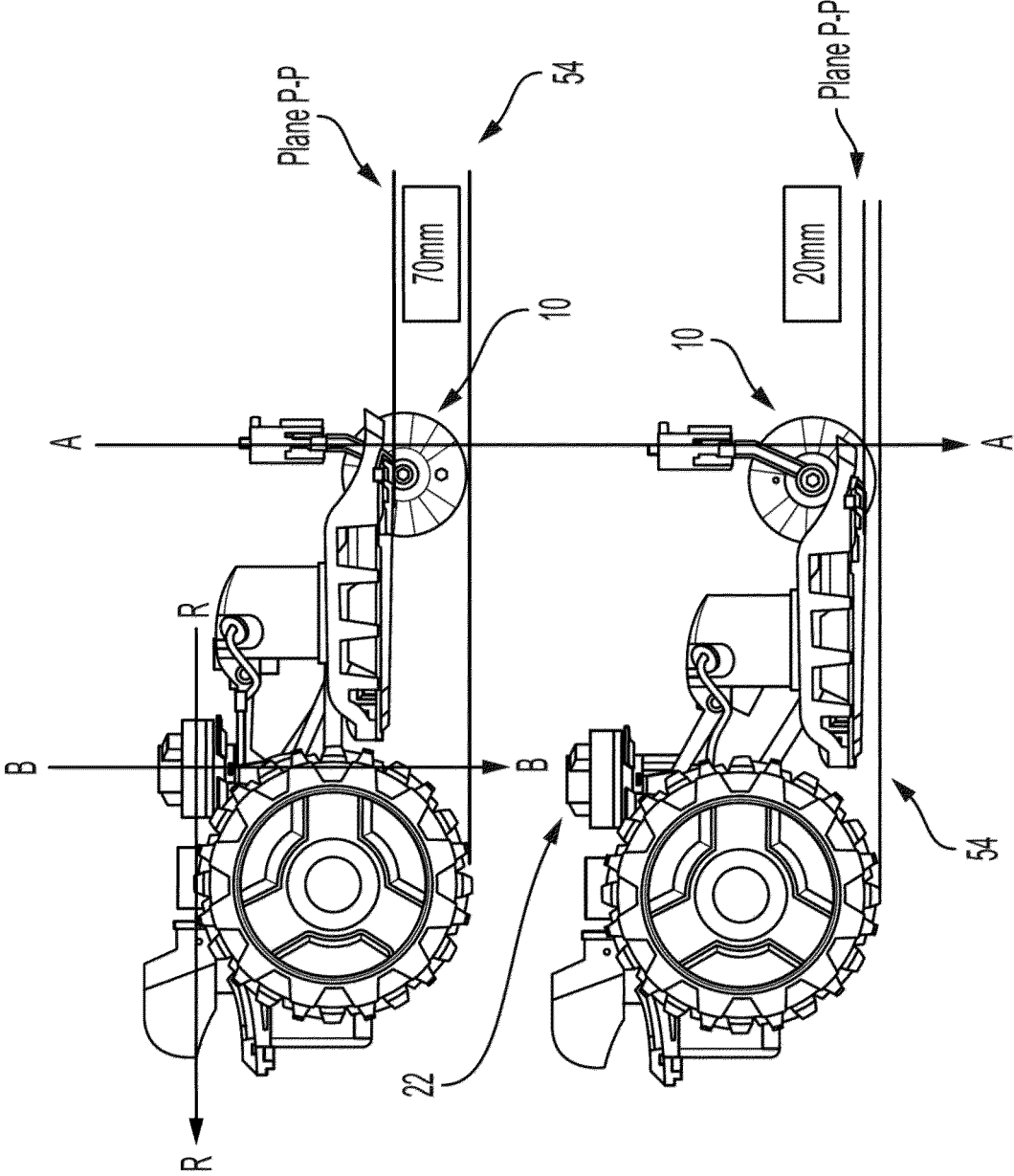


FIG. 6

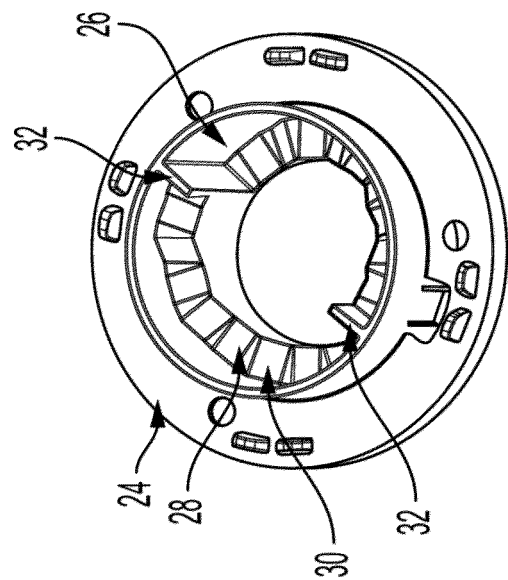


FIG. 7

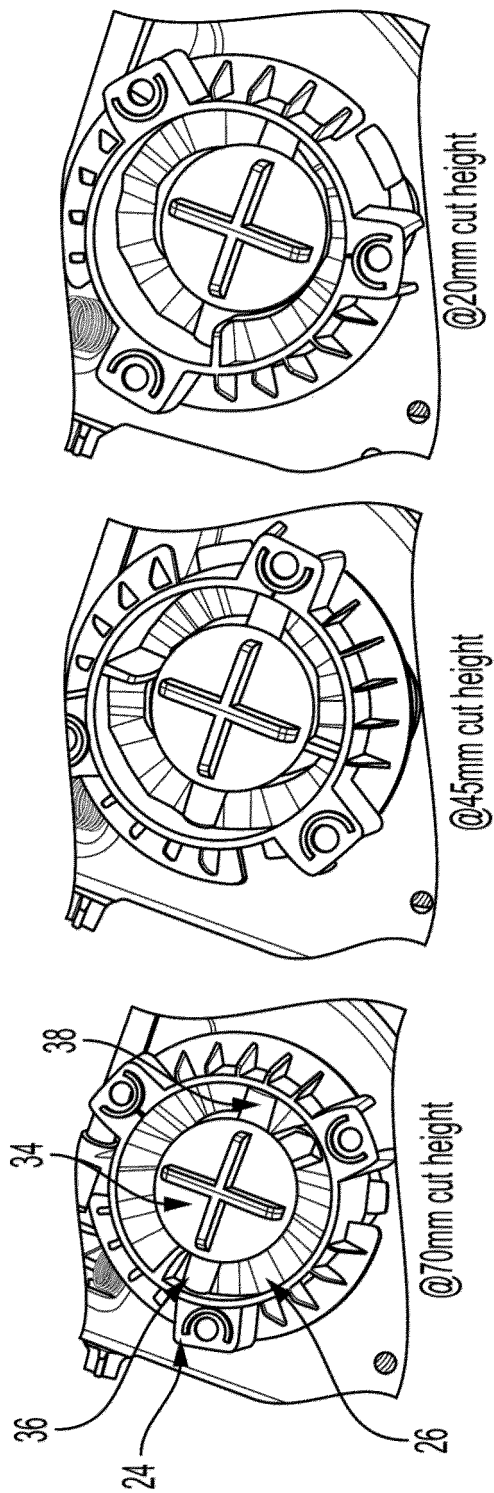


FIG. 8

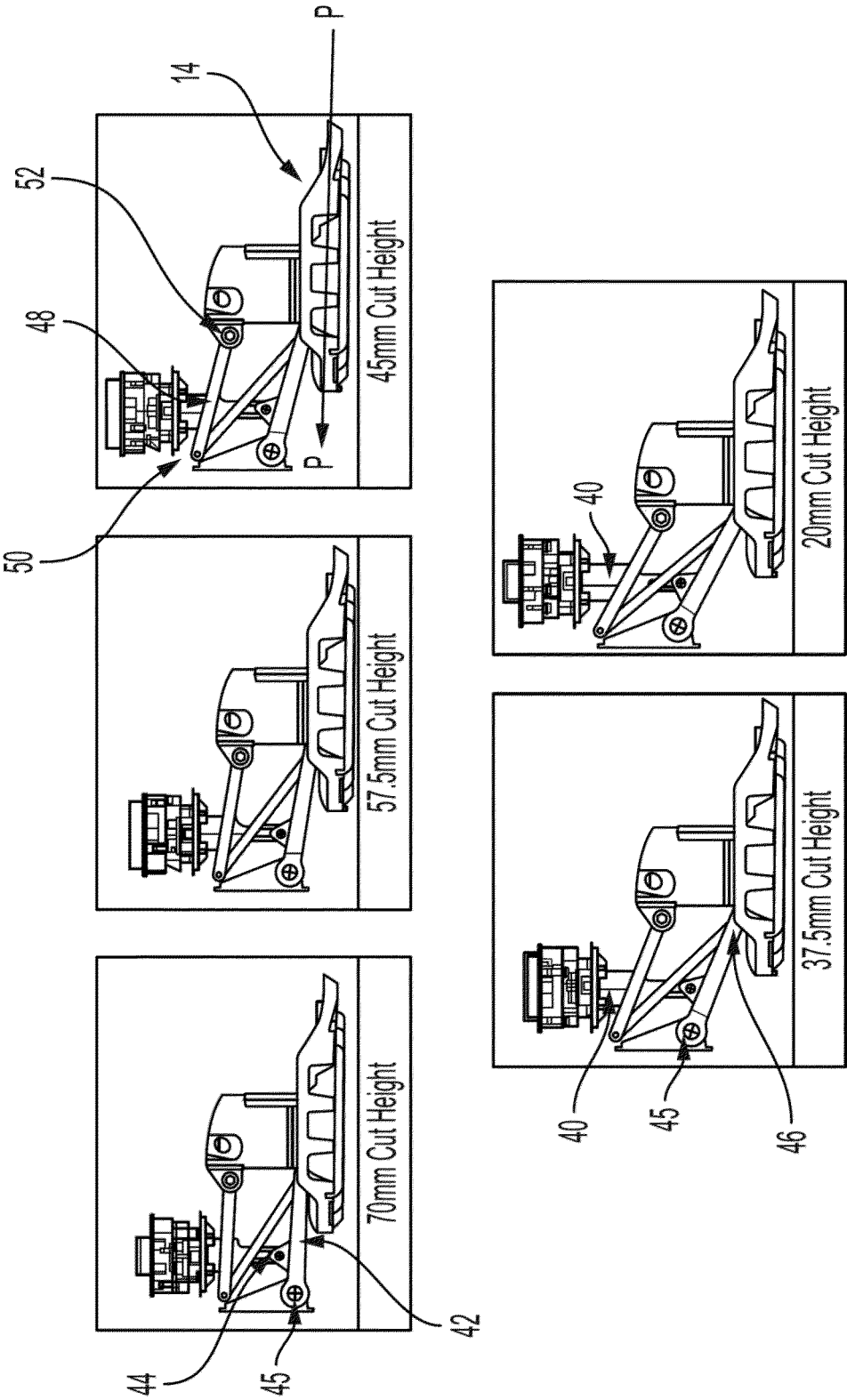


FIG. 9

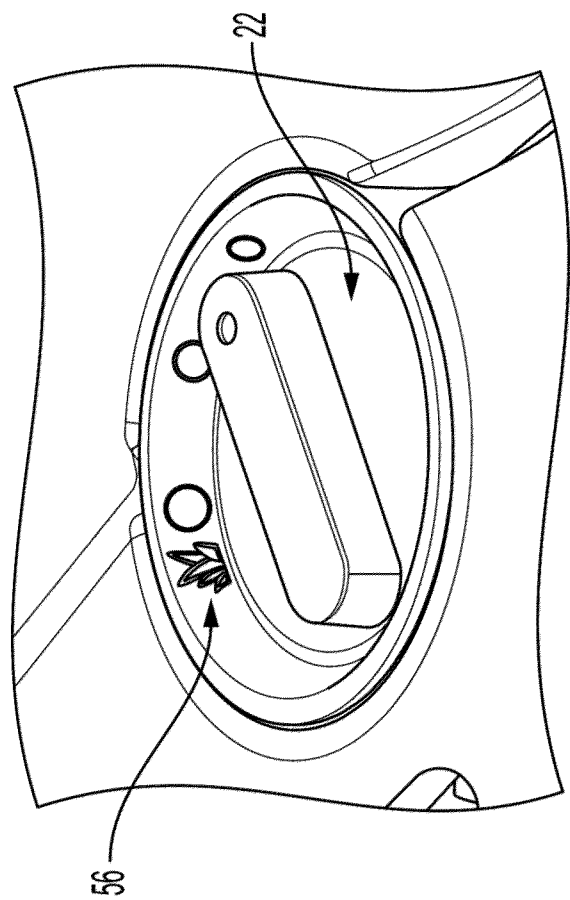


FIG. 10



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